Grape Insect and Mite Pests, 2022 Field Season

Greg Loeb, Department of Entomology
Cornell AgriTech, Cornell University
New York State Agricultural Experiment Station, Geneva NY 14456

Greetings all. Budbreak is upon us and another field season is getting underway. Among many other things, it's a good time to re-engage your brain around crop protection. Dr. Katie Gold has distributed her "magnum opus" for vine diseases recently and here is my review of grape insect and mite pests My goals for this review are to 1) review the main arthropod pests to keep in mind as the season progresses, including new invasive insects that pose a risk to grapes, 2) provide some basic background on biology and ecology that helps in understanding different approaches to management, 3) summarize relevant results from recent research, and 4) provide an update on changes in chemical control options. I want to acknowledge and thank the extension educators out in the grape growing regions of New York and Pennsylvania for their assistance and input for this review as well as Brian Eshenaur's (NYS IPM program) input on spotted lanternfly. Let me get started by highlighting changes in the NY and Pennsylvania Grape Guidelines for 2022.

Update from NY and Pennsylvania Grape Guidelines and other chemical news

There are only a few changes to insecticides and miticides available for use on grapes in the 2022 grape guidelines relative to 2021. I am not aware of any new insecticides labeled for grapes, although there are a few new chemistries being tested against some of our important grape pests such as grape berry moth. Wayne Wilcox always cautioned that it is foolish to put a specific date on when new chemistries would actually get labeled, so I will avoid doing that here. But it is nice to know there are few things in development that would be helpful. Several products have updated labels that include some changes in a few cases. I noted this last year, but it's worth repeating, that there has been a reduction in days to harvest restrictions for Delegate [spinetoram, a synthetic spinosyn) and Entrust SC [spinosad, an organic formulation of spinosyn]. On the new labels for Delegate and Entrust SC, the days to harvest restriction has been reduced from 7 days to 3 days, which if used for pests near harvest such as spotted wing drosophila (note in NY need 2ee label exemption to use Entrust SC for spotted wing drosophila on grapes), the reduced DTH provide for more options in managing sour rot. As mentioned last year, use of Lorsban [chlorpyrifos) is no longer allowed in grapes and therefore, I have removed it from the guidelines. This is not a major loss for grapes in NY in that it was not being used that much and there are effective alternatives. Losing Lorsban in PA could be problematic in that it is the only insecticide labeled for use against grape root borer (as a soil barrier), which is present in parts of PA but not yet been found in NY. I added a couple of products for controlling spotted wing drosophila in the 2022 grape guidelines (Assail [acetamiprid], Baythroid [cyfluthrin] and Grandevo [*Chromotacterium subtsugae*] that I had missed in 2021. Note that you need 2(ee) to use Assail or Baythroid for controlling SWD in NY. Finally, for controlling spotted lanternfly (SLF), there is now a special local needs 24c for the use of Brigade 2C [bifenthrin] post-harvest. With this SLN 24c, you are allowed to apply Brigade 2C twice post-harvest if no pre-harvest applications have been made. Note that bifenthrin is quite effective against adult SLF and that in areas with high populations of

SLF near vineyards, post-harvest colonization is common (see update below).

Update on Spotted Lanternfly

Spotted lanternfly (SLF) has continued to spread out from its area of first detection in Pennsylvania, including into New York. The NYS IPM program has been regularly updating the reported distribution map for SLF and you can go to this link to see the latest update (https://nysipm.cornell.edu/environment/invasive-species-exotic-pests/spotted-lanternfly/). Native to parts of Asia, this phloem-feeding planthopper was first discovered in the USA in the fall of 2014 in Berks County, PA. It can build to very large numbers and feed on ornamental plants, native perennials, fruit trees and grapes. Indeed, in the quarantine zone in PA, grapes are the most negatively impacted crop by SLF. SLF is has now been causing damage to grapes in Virginia and New Jersey. So far SLF has not been found in any NY vineyards, although it is getting close in the Hudson Valley and on Long Island. There is a sizable established population near Binghamton, NY and its very well established downstate around NY City. NYS Agriculture and Markets is leading NY's SLF efforts, working closely with USDA APHIS and Cornell (NYS IPM program, NE IPM program). NY growers can find more information on identification of SLF, signs of infestation, and reporting at NYS Ag & Mkts web site at https://agriculture.ny.gov/spottedlanternfly , along with the NYSIPM web site indicated above. It would not totally be surprising if we have our first observations of SLF in a NY vineyard this year or in a vineyard in the Lake Erie Grape Belt. If that does occur, its important not to panic. Experience elsewhere shows that it takes several years between initial establishment and when populations have built up sufficiently to cause economic damage. Once that does happen, we do have a number of insecticides that are effective in killing adult or immature SLF (see below for more information).

Figure 1. SLF egg mass (above) and Adult SLF (below).

As a quick reminder on the life cycle of SLF, it has only one generation per year. It overwinters in the egg stage. Egg masses are laid on all sorts of surfaces (trees, brick walls, carts, trailers, etc.) in late summer (see Fig. 1), starting in August and continuing late into the fall. The eggs hatch in the spring, probably about the time this newsletter gets circulated. The nymphs feed on various host plants, though the tree of heaven is a preferred host, before becoming adults in the late summer (see Fig. 2).

Figure 2. Adult SLF with wings extended showing warning coloration.

PA entomologists have several ongoing research projects examining the biology and management of SLF, including some work on chemical control options for vineyards. Based on their research and other resources, Juliet Carroll, Dan Gilrein and others have compiled a list of insecticides that are labeled for use on grapes in NY for SLF (see https://nysipm.cornell.edu/sites/nysipm.cornell.edu/files/shared/documents/Insecticides-for-Control-of-Spotted-Lanternfly.pdf). This information can also be found in the grape guidelines. For NY, several of the insecticides require the 2(ee) label exemption allowing use against SLF. A couple of things to keep in mind regarding management of SLF in new areas of the invasion. As noted above, it will take time for populations to build to a level that requires chemical control. So I expect you will have some time to get a pest management strategy organized if SLF is found in or near your vineyards. Second, the insecticides we have available are generally effective in killing either the nymphal and/or adult SLF stage. The big problem they are seeing in areas of PA where SLF is well established is that they build to high numbers in the surrounding landscape and then adults disperse into vineyards over an extended time period making it challenging to keep up.

This phenomenon where adult SLF migrate into vineyards in waves that are difficult to control brings up the question of trying to manage them outside the vineyard. SLF nymphs and adults feed on many different wild plants as they develop and mature, but they clearly perform better and are more fecund as adults when feeding on the invasive tree of heaven (TOH, *Ailanthus altissima*). In vineyard sites where TOH is abundant in the adjacent habitat, there is the possibility that by removing these SLF host plants, SLF pest pressure in the vineyard can be reduced. Penn State Extension has put together an informative fact sheet on how to identify TOH and methods for removal (https://extension.psu.edu/tree-of-heaven). Herbicides are the preferred approach to controlling TOH but you need to be very careful with their use to avoid non target effects, including issues with drift into the vineyard. A related possible management tactic for SLF outside the vineyard in situations where TOH is abundant is to remove most of the trees but keep a few males (the sexes of TOH are separate; males will obviously not produce seeds) as trap trees to concentrate SLF that then can be killed with a systemic insecticide such as Safari [dinotefuran]. The idea of a trap tree is sound and treated trees can kill many hundreds of SLF, though to my knowledge a corresponding reduction in SLF in adjacent vineyards has not been confirmed through experimentation in the field. I will continue to explore these “outside of the vineyard” approaches for managing SLF, including any legal issues that might occur, and report back.

Review of key arthropod pests

Unlike the situation with grape diseases, where there is a clear big 4 or 5, for arthropods there is one key pest (grape berry moth) that is widespread and causes serious damage most years and then a dozen or more pests that can create major problems but typically vary in abundance and pest potential from season to season and place to place. It’s clearly a challenge to be able to recognize all of these potential pests and/or their symptoms and be familiar with different management options. Hopefully this review will be of use in this regard. I will focus on the grape pests that have a moderate to large potential to cause economic injury as we progress through the field season. For completeness sake, I am including information that is pretty much a repeat from previous years. Pay particular attention to updated information on grape mealybug and grape leafroll disease and fruit flies and sour rot. More details on control measures can be found in the New York and Pennsylvania Pest Management Guidelines for Grapes: 2022. For greater focus on organic options, refer to the online organic grape guide at https://ecommons.cornell.edu/handle/1813/42888 . Before applying any chemical control measure make sure to read the label, taking into account things like mode of action (IRAC code), potential for phytotoxicity, labeled pests, re-entry and days to harvest intervals, effects of pH, compatibility with other pesticides, seasonal and per application restrictions, and impact on beneficials. The IRAC code categorizes active ingredients by how they mechanistically impact the arthropod. To reduce the risk of some species developing resistance to a particular active ingredient, its prudent, where possible, to rotate among different modes of action. Also keep in mind that in NY, the pest needs to be on the registered product label to be used, unless a 2(ee) exemption has been approved and is in hand. This extra requirement is not the case in PA and most other states.

Arthropods are generally detectable in the field before they cause economic injury. Moreover, most insecticides and miticides work as eradicants as opposed to preventative agents. They can be quite expensive and some are harsh on beneficial insects and mites. Because of all these factors, it is advisable to monitor pest densities and only apply control measures when economically justified.

Budswell to Bloom

Steely Beetle (grape flea beetle) and Climbing Cutworm

The steely beetle (small, shiny black or dark blue in color) overwinters as adults and become active as temperatures increase in the spring. A fact sheet on steely beetle can be found at https://ecommons.cornell.edu/bitstream/handle/1813/43101/grape-flea-beetle-FS-NYSIPM. pdf?sequence=1&isAllowed=y. They feed on swollen buds prior to budbreak with the potential of causing considerable damage under the right conditions; specifically when we get a prolonged swollen bud stage. Look for damage from steely beetle along the edges of the vineyard. After budbreak the adult steely beetle is no longer a threat. Although steely beetle larvae will feed on grape leaves later in the early summer, this damage is not economically important. Climbing cutworm (fact sheet at https://ecommons.cornell.edu/bitstream/handle/1813/43085/climbing-cutworms-FS-NYSIPM.pdf?sequence=1&isAllowed=y) refers to larvae of several species of Noctuid moths that cause a similar type of damage as steely beetle. Larvae hide during the day in the leaf litter or grass below the vine and then climb up into the vine to feed on buds and very young shoots on warm evenings. Grass under the vine may increase problems from cutworms. Use about 2% bud damage from either species as a threshold for treatment. Some hybrids with fruitful secondary buds that tend to overcrop can probably handle higher damage levels. For many sites, this newsletter article probably will arrive after the time buds and young shots are vulnerable to feeding by steely beetle adults or cutworms. There are several effective, broad-spectrum, insecticides labeled for steely beetle and climbing cutworm in grapes. Rather than providing a complete list here, I refer you to the guidelines.

Soft Scales and Mealybugs

Soft scales and mealybugs are sucking insects that spend part of their life-cycle on the canes or the trunk and part on leaves or fruit. At high densities they can reduce vine vigor or contaminate grape clusters with their sugary excrement, which supports the development of sooty mold. However, the major concern with soft scales and mealybugs in our area relates to their potential to vector viruses that cause grape leafroll disease. This is a serious disease of *V. vinifera* grapevines (a fact sheet on leafroll is available at https://ecommons.cornell.edu/bitstream/handle/1813/43103/grape-leafroll-FS-NYSIPM.pdf?sequence=1&isAllowed=y). Soft scales and mealybugs are able to vector grape leafroll disease even at low densities. Indeed, the more we look, the more vineyard sites we find that have either soft scales or grape mealybug or both types at low densities. Soft scales in our area overwinter on canes as large immatures or young adults. At this stage they vary in shape and color but are typically brown or gray and look like bumps or large scales on the canes. They have limited ability to move at this stage. As the spring progresses, they complete development, mate and begin laying eggs (mid-May to early-June), often many hundreds to over a thousand per female. The eggs hatch into mobile crawlers that disperse out on to the foliage to feed. The significant species of soft scales found on grapes in our area (lecanium scale, cottony maple scale) have just one generation per year. As they mature during the season, they move back to the canes to overwinter.

Grape mealybug in our area predominantly overwinters on canes or trunks as crawlers (first immature stage after hatching from eggs) near their egg sack, moving out from trunk wood to first or second year wood in spring (at budswell, see Fig 3). These crawlers like to hide under loose or cracked bark; look where one-year canes have been bent over trellis wire. As they become adults, they move back to the trunk region to lay eggs (around mid-June). The first instar crawlers (summer generation) are observed around the beginning of July. These crawlers go on to mature, being found on various tissue including clusters. As they become adults, they migrate back to the trunk regions to lay eggs (mid-August), which mostly hatch and then spend the winter as first instar crawlers. Working with Dr. Marc Fuchs, virologist at AgriTech, we have documented that grape leafroll disease has increased within a vineyard over time in several different vineyard blocks in the Finger Lakes indicating that insect vectors are likely responsible. Note that the virus is not passed on to the eggs from the female.

Fig. 3. Grape mealybug. photo: Steve Hesler

The newly hatched crawler must acquire the virus when it feeds to be able to transmit to it. Once acquired from an infected plant, if the insect moves on to an uninfected vine before it molts, it can spread the disease. Since crawlers are the most active stage of both mealybugs and soft scale, they are the most likely stage to spread the disease. Our research has shown that overwintering crawlers in November were generally not infected with grape leafroll associated viruses (GLRaV) even though they were present on infected vines. However, we discovered that in April/early May the now overwintered crawlers were infected at high levels

(>70%) suggesting they had fed on the vine and acquired the virus sometime between late fall and late April prior to budbreak. We hypothesize that the crawlers may be particularly important in spreading the virus within a vineyard during the spring since there is little or no foliage to impede movement from vine to vine.

An important question is whether insecticides targeting the insect vector can be used to slow the spread of leafroll disease within a vineyard? Experiments conducted over the past several years suggest that using an effective insecticide against grape mealybug, such as Movento [spirotetramat], can slow the spread to some degree. The results were not overwhelming, however, and disappeared the year after we stopped applying Movento. It is possible that combining effective chemical control of the vector with rogueing out infected vines may suppress or stop the spread of the disease. We have been testing this idea at a vineyard in the Finger Lakes over the past six years. We have four treatments (with replication): rogue out leafroll infected vines and the two neighbor vines on either side within a row (the recommended approach when disease incidence is below 25%), treat vines with insecticide (split applications of Movento, at about bloom and one month later), rogue and treat with insecticide, or do nothing (control). We have documented excellent control of mealybugs in plots treated with insecticide (Fig 4). The impact on leafroll disease is more complicated. Over time rogueing greatly reduced the number of new infected vines to virtually zero. We see a similar pattern for rogueing plus insecticide. A careful

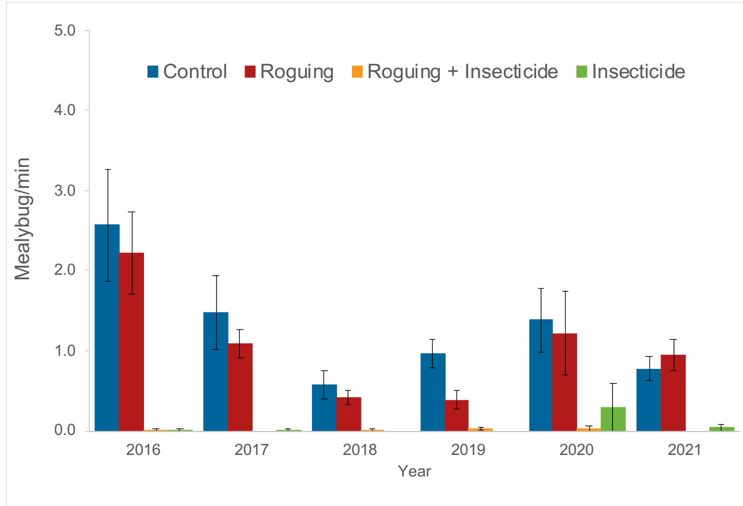

Fig. 4. Visual counts of grape mealybug in sections of a Cab Frank vineyard that received Movento, roguing, both Movento and roguing, or nothing from 2016 to 2021.

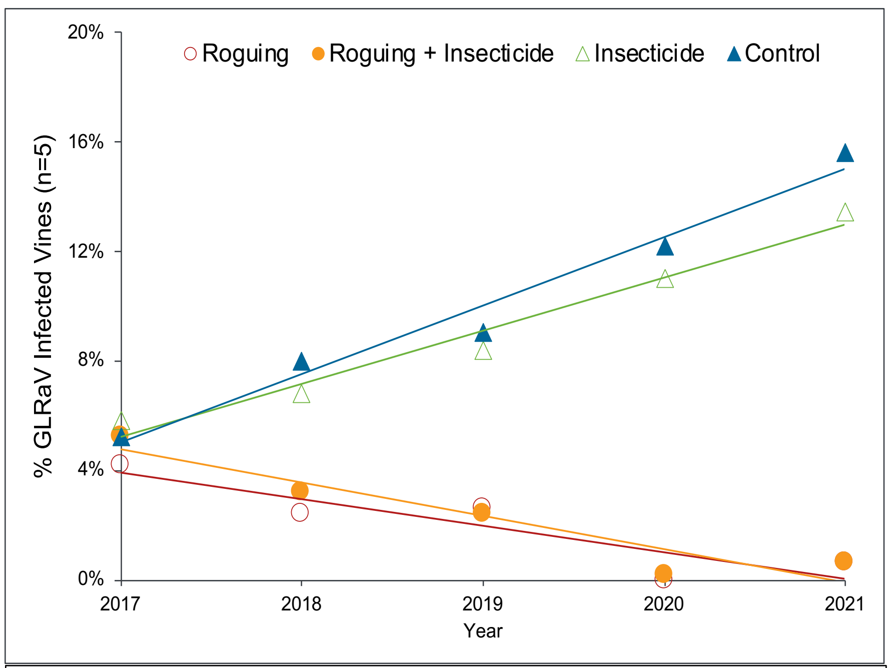

Fig. 5. % leafroll infected vines in sections of a Cab Frank vineyard that received roguing, Movento, both Movento and roguing, or nothing from 2016 to 2021.

examination of the data from this experiment indicates that the strategy of removing two vines on either side of an infected vine, something referred to as spatial rogueing, is justified, for at least several seasons. Interestingly, and somewhat surprising, controlling the vector (grape mealybug) without rogueing had little impact on spread of leafroll (see Fig 5). Under higher mealybug populations it is possible that treating them with insecticide, in combination with rogueing, would be beneficial in controlling disease and perhaps more effective than rogueing alone.

There are multiple insecticides labeled for use against grape mealybug. Fewer options are labeled for soft scale. See Grape Pest Management Guidelines for a full listing. For both pests, there are two times during the season where chemical control is potentially effective: in the spring at or just prior to budbreak targeting the overwintering stage of the insect and during the growing season right after egg hatch targeting the crawler stage (first instar immature). A delayed dormant oil application has been shown to be effective in controlling soft scale in other crops and I would expect it would work in grapes, though I have not specifically tested this. The oil smothers the soft scale, which are often out on the canes where they are exposed. Delayed dormant oil was not particularly effective against grape mealybug in our trials, however. We believe that is because the overwintering mealybug crawlers are protected under loose bark on the trunk.

As noted above, during the growing season the systemic insecticide Movento [spirotetramat] has been very effective in controlling grape mealybug in our trials (2 applications, 6.25 fl. oz/A per application, 30 days apart). As a reminder, spirotetramat is also one of the active ingredients in Senstar. Both the Movento label and Senstar label for grapes now include suppression of European fruit lecanium scale. The neonicotinoid insecticides Admire Pro [imidacloprid] and Platinum [thiamethoxam] (not allowed on Long Island), when applied through a drip system and therefore systemic throughout the vine, are effective against grape mealybugs. Admire Pro (when applied via drip to soil) also includes European fruit lecanium scale on the label. Since the crawlers actively move around the vine they are more likely to get exposed to the insecticide residue and therefore crawlers are best target for insecticides that work by contact. The question is how to time egg hatch? Right now we don’t have a validated degree-day model to predict this timing. A number of years ago, however, we did obtain some initial estimates and found egg hatch for grape mealybug occurred at around 800 DD (starting Jan 1, base 50 F) which that year was around July 1 while we observed the first crawlers of soft scale insects at around 650 DD (starting Jan 1, base 50 F) which that year was third week of June. If you do have soft scale insects or mealybugs in your vineyard, one thing you can do is check the status of eggs underneath soft scale (mostly on canes) or adult grape mealybug females (under loose bark on trunk wood). With a hand lens you should readily be able to see the eggs and crawlers if present.

During the growing season carbaryl is labeled for European fruit lecanium and an insect growth regulator called Applaud [buprofezin] is labeled for both soft scale and mealybugs. *Note that Applaud is not legal to use on Long Island*. Another insecticide labeled for lecanium scale on grapes is Knack [pyriproxyfen, the same active ingredient combined with spirotetramat in Senstar], an insect growth regulator. Knack is allowed on Long Island.

Plant bugs

There are at least two species of plant bugs that have the potential to cause significant damage tograpes prior to bloom: banded grape bug and *Lygocoris* bug. These insects are only a threat up to bloom. Both species overwinter as eggs, presumably on grape canes, emerging as nymphs shortly after budbreak to 5 inch shoot growth. The banded grape bug (BGB) nymph is greenish to brown in color with black and white banded antennae (see Fig. 6). Nymphs of *Lygocoris* are pale green with thin antennae and about half the size of BGB. Nymphs of both species **can** cause serious economic damage by feeding on young clusters (buds, pedicel and rachis) prior to flowering. Adults, which appear close to bloom, do not cause economic damage and for at least one of the species (BGB), become predaceous on small arthropods. There is only one generation per season. Monitor for nymphs by examining flower buds on approximately 100 shoots along the edge and interior of vineyard blocks. A video demonstrating scouting techniques for banded grape bug can be found at https://www.youtube.com/watch?v=FrEJ6IJB_is. These plant bugs are sporadic from year to year and from vineyard to vineyard; most vineyards will not require treatment. If present at relatively low numbers (1 nymph per 10 shoots), they can cause significant yield reductions and hence it is worth the time to check. Pay particular attention to vineyard edges. Remember, though, by the time you reach bloom, it is too late to treat. There are several insecticides labeled for use against plant bugs (Imidan [phosmet], Danitol 2.4 EC [fenpropathrin], Assail 30 SG [acetamiprid] and Cyclaniliprole + Assail).

Figure 6. Image of a banded grape bug nymph on a grape cluster. Photo by Joe Ogrodnick, Cornell AgriTech.

Grape Plume Moth

This is another potential pest of grapes that overwinters as eggs in canes and emerges shortly after budbreak. Larvae typically web together young leaves or shoottips and leaves to form a protective chamber from which they feed (Fig. 7). Research indicates 1) that damage tends to be concentrated on the vineyard edge near woods and 2) that it takes quite a few plume moth larvae to cause economic damage. For Niagara grapes we were unable to detect a statistical effect on vines with 20% infested shoots compared to control vines. Nevertheless, the trend was for reduced yield associated with high plume moth infestations (>20%). For higher value cultivars a somewhat lower threshold would be

Figure 7. Grape plume moth larva and damage. Photo: J Ogrodnick, Cornell AgriTech.

appropriate. Treatment of plume moth can be tricky for several reasons. First, the larvae develop very quickly and often have reached the pupal stage before you even recognize thereis a problem. Second, larvae inside their leaf shelters are protected from insecticides. For these reasons, it's important to monitor and treat for plume moth early in the season (before 10 inch shoot stage) using sufficient water to achieve good coverage. Danitol is the only insecticide labeled for use against grape plume moth in NY (2(ee) recommendation). Dipel can be used in PA, as well as some other insecticides labeled for use on grapes.

Grape Cane Gallmaker

The grape cane gallmaker is a beetle in the weevil family. You can find a fact sheet on GCG at https://ecommons.cornell.edu/bitstream/handle/1813/43098/grape-cane-gallmaker-FS-NYSIPM.pdf?sequence=1&isAllowed=y. The adult is quite small (less than ¼" or 3 mm long) and reddish brown in color (Fig. 8). Adults overwinter in debris on the ground and become active in Spring. Egg-laying occurs in May and June when shoots are between 5" to 20" (25 to 50 cm) in length. The female weevil hollows out a small cavity along the shoot just above a node and places a single egg. She fills the cavity with frass and then goes on to create additional cavities along the shoot (up to 14). Only the first has an egg, although other adults may join in such that you can find more than one gall with a larva per shoot. In response to the adult weevil feeding damage, the vine forms a gall (swelling) around each of the cavities (Fig 9). The egg hatches and the larva feeds on grape tissue that forms around the cavity, emerging as an adult later in the summer. The galls typically do not kill the shoot but can create areas of mechanical weakness that can lead to breakage (Fig 10). And if numerous enough, galls can truncate shoot growth.

Fig. 8. Adult grape cane Gallmaker.Photo: J. Ogrodnick

Figure 9. Recent cavity on grape shoot made by female grape cane gallmaker. Photo: J. Ogrodnick.

Grape cane gallmaker is considered a minor pest, generally not requiring control. However, there have been increasing reports of extensive galling on grapevines of several different cultivars in the FingerLakes region, especially around Keuka Lake, but also Seneca Lake, to the extent that chemical control may be warranted. Insecticides should target the adult stage during May and June. In severe situations, multiple applications, starting at 2-4 inch shoot growth, may be necessary to get things under control. There are a limited number of products labeled for grape cane gallmaker including Danitol, Baythroid, and Leverage.

Fig. 10. *Grape cane* gallmaker gall, dormant season. Photo: J. Ogrodnick

Rose Chafer

Rose chafer is a beetle in the same Family (Scarabaeidae) as the Japanese Beetle. Rose chafer adults feed on a variety of host plants (e.g., roses, tree fruit, small fruit, etc.) but in our area the preferred host is grape. Although rose chafers are not a widespread problem, in some vineyards in the Lake Erie Region, these beetles **can cause significant crop loss** in vineyard blocks where they occur. Vineyard blocks with sandy soils (particularly sandy sites from the lake front to just south of Route 5 in North East, Pennsylvania) have the most persistent problem with this pest. I have also seen spotty problems on sandy knolls in some blocks in the grape belt. Every year in early June (about 7-10 days before bloom) in the Lake Erie Region, large numbers of rose chafer beetles emerge from the soil at the same time and begin mating and feeding extensively on tender flower clusters. Beetles will also feed on grape leaves but over the years I have only seen minimal injury on Concord leaves. Feeding continues to occur in vineyards for about a 3 week period. Fortunately, there is only 1 generation per year. Adult beetles are about ½ inch long, have a light brown-tan body coloration and long, spiny legs (Fig. 11). Females prefer laying eggs in grassy areas with sandy soils. Rose chafer grubs are C-shaped and have a white body with a brown head capsule. They are similar in appearance to Japanese beetle grubs. These larvae feed on roots of grasses, weeds and other plants during the summer. Vineyards with a history of this pest or blocks with sandy soils should begin scouting about 10 days before bloom. Scouting for this pest should be conducted daily, if possible, but at a minimum of 3 times/week and should continue for about 2 weeks after bloom. Infested areas can lose extensive numbers of flower clusters if beetles are not detected early and treated. Research from Ohio State recommends an insecticide application if a threshold of 2 beetles per vine is reached. Blocks with high populations of rose chafers may require a second insecticide application. Insecticides for management of rose chafer listed in the guidelines include Assail, Danitol and Sevin.

Fig. 11. Adult rose chafers on grape cane. Photo: J. Ogrodnick, NYSAES

Bloom to Mid-season

Grape Berry Moth

Grape berry moth (GBM) is familiar to most grape growers in our region. Despite this familiarity, managing this pest is still challenging, especially late in the growing season. I believe the key to successful management of GBM is having a good understanding of its phenology (timing of the different stages of its life-cycle), combined with scouting and use of the Grape Berry Moth Degree Day Model found on NEWA, so that management actions are properly timed. Of course, getting good spray coverage on fruit is also critical, which can be a challenge in itself, especially later in the season for cultivars with dense canopies like Concord.

GBM has several flights during the growing season (3-4) starting around bloom and continuing, in some years, into September. A temperature-driven phenology model has been developed for GBM, using bloom date of wild grapes as the starting point for accumulating degree days (biofix), that helps predict timing of egg-laying associated with these flights. Knowing when most eggs are laid is important for effective chemical control since insecticides mostly target the young larvae before they have a chance to enter the berry where they are pretty protected. The GBM phenology model is available to growers through the Network for Environment and Weather Applications (**NEWA**) web site (http://newa.cornell.edu/) along with management guidelines. The GBM model is most useful for timing the second and third flights of the season, but less helpful for timing subsequent flights. The reason is that by late season, the flight period becomes less synchronous and more spread out such that eggs are being laid continually. **Therefore, we are recommending growers use the phenology model to time the second and third flights but beyond that, in warm years and for high risk sites, growers should continue spraying on a 7 to 10 day rotation until about mid-September when egg laying pretty much stops.** NOTE: According to the Grape Berry Moth Degree Day Model: *"If 1620 DD occurs prior to August 5, you can expect continuous pressure from grape berry moth through harvest. Model results are not good predictors of timing of population pressures."*

At any given date, the model will provide the degree-day accumulations from the biofix, a forecast of accumulation over the next several days, and pest management advice based on current degree day accumulations. For example, as accumulation gets close to 810 degree days (the estimated degree days required to develop from an egg to an egg-laying female moth), the program notes that this is approaching the peak of the second GBM flight and you are advised to apply an insecticide at near 810 for a high risk site and to scout for damage for low or intermediate risk sites. The NEWA forecast makes a distinction between insecticides that need to be consumed (e.g. Altacor [chlorantraniliprole], Intrepid [methoxyfenozide]) where the timing should be close to 810 degree days and those that work mostly through contact (e.g. Brigade, Danitol, Baythroid, Sevin) where timing should be between 810 and 850. I wanted to briefly mention scouting for GBM damage. It's important for both intermediate and high risk vineyards for the second and third generations to scout for damage. The timing of scouting should be just prior to predicted peak flight and initiation of egg- laying (810 degree-days after biofix for second generation and 1620 degree-days after biofix for third generation). If it were easy to see GBM eggs, then the scouting could be helpful for timing insecticide applications. However, it is very difficult to scout for eggs. Therefore, the purpose of the scouting is to get a handle on potential damage levels and whether you are exceeding economic thresholds. For Concord grapes, if the percent of clusters that show some GBM damage to berries is <6% at second flight and <15% at third flight, then a treatment is not recommended. These levels can be used as a guide for wine grapes. However, for high value vinifera cultivars, especially cultivars with tight clusters prone to fruit rots, the thresholds probably should be lower. Note that for super high risk sites where GBM damage can be extreme, we do recommend a spray at the traditional 10-day postbloom period that targets offspring of the first flight of the season. For most vineyard sites, though, the 10-day postbloom spray does not provide much benefit.

There are many options available for chemical control of GBM. See **New York and Pennsylvania Pest Management Guidelines for Grapes** for a full listing. The most commonly used products are the pyrethroids (Danitol, Brigade (including several generic products with same active ingredient), Baythroid, Mustang Maxx, Hero). Pyrethroids are broad-spectrum and will kill a number of other insect pests, as well as beneficial insects. Leverage and Brigadier both include a pyrethroid that provides control of GBM and a neonicotinoid that provides good control of sucking insects like leafhoppers (see below). Other broad-spectrum insecticides labeled on grapes for GBM include Sevin and Avaunt (carbamate class) and Imidan (organophosphate class).

There are several additional, more narrow-spectrum, materials registered for use against GBM. Dipel, Biobit, and Deliver are organic options that have been around for a number of years. The toxin produced by the *Bacillus thuringiensis* (Bt) bacteria is specific to Lepidoptera. We have found that 2 applications of Bt per GBM generation improves efficacy. Use sufficient water to achieve good coverage of fruit since the larvae must consume the Bt as they enter the berry for it to be effective. Good coverage is an issue for all the GBM materials. Delegate is another fairly selective material that has been effective in our trials. The insect growth regulator Intrepid has proven quite effective in trials in New York, Michigan and Pennsylvania and has been in use on grapes in many states for nearly 20 years. Relatively recently New York grape growers are allowed to use Intrepid for GBM management through a Special Local Needs label (but not for use in Nassau and Suffolk Counties). A copy of the SLN label, and the Intrepid label, must be in the possession of the applicator if Intrepid is applied in NYS. Intrepid is a selective material active against the larvae and eggs of many species of Lepidoptera including GBM. Intrepid has fairly long residual activity and is an excellent choice for the second-generation treatment in July as it may provide some control of the overlapping third generation as well. Finally, several anthranilic diamide insecticides (diamides) have been labeled for use on grapes for GBM (also not allowed on Long Island) in the last several years (Altacor WG, Verdepryn 100 SL, Cyclaniliprole 50 SL, Voliam Flexi WG [chlorantraniliprole + thiamethoxam]). These materials are pretty selective for Lepidoptera such as GBM and have pretty good residual activity. Similar to Intrepid, Delegate, and Bt, they work best when ingested by the first instar (recently hatched) larvae as they try to move into the fruit.

Mating disruption involves the release of the synthetic version of the sex pheromone that a species uses to locate mates. The synthetic pheromone interferes with mating thereby reducing the amount of egg-laying. Mating disruption has been successfully used for a number of different insect pests of fruit crops, especially Lepidopteran pests where females release a specific-specific pheromone that attracts males for potential mating. There is a mating disruption product for GBM (Isomate-GBM plus) although it is no longer available for sale in NY or PA. The company was not making sufficient sales to justify continuing to market their product. It is still being sold and used in Canada. Several of us tested Isomate-GBM plus in NY, PA and MI in mostly concord vineyard blocks a few years ago with mixed results. In general, mating disruption works best when used over larger acreage (area-wide disruption).

Grape Leafhoppers

There is actually a suite of leafhoppers that feed on grapes. The Eastern grape leafhopper *Erythroneura comes* (pale white in summer mainly feeds on native cultivars like Concord (see fact sheet at https://ecommons.cornell.edu/handle/1813/43102) while several additional species feed on *V. vinifera* and hybrids including *E. bistrata/vitifex*, *E. vitis*, *E. vulnerata*, and *E. tricinta*. All these Erythroneura leafhoppers have similar life-cycles. They overwinter as adults and become active as temperatures warm up in the spring. They move on to grapes after budbreak, mate and begin laying eggs around bloom. There is one full generation during the summer and a partial second. In warm years there is a potential for a nearly full second generation of nymphs and adults. Both nymphs and adults cause similar damage; removal of leaf cell contents using sucking mouthparts causing white stippling (Fig 12). Hence, moderate densities can reduce photosynthesis, ripening and yields. Severity of damage is increased in dry years, assuming irrigation is not available. Sampling for leafhoppers corresponds to sampling for grape berry moth. At the immediate post bloom period sucker shoots should be examined for evidence of stippling (white dots on leaves caused by leafhopper feeding). If you see stippling throughout the vineyard block an insecticide treatment is recommended. The next sampling period for leafhoppers is mid-July and focuses on abundance of first-generation nymphs. Check leaves at the basal part of shoots (leaves 3 through 7) for leafhopper nymphs or damage, on multiple shoots and multiple vines locatedin the exterior and interior of the vineyard. Use a threshold of 5 nymphs per leaf. The third time for sampling for leafhoppers should occur in late August. This focuses on nymphs of the second generation. Follow a similar sampling protocol as used at the end of July, using a threshold of 10 nymphs per leaf. Note if you have made previous applications of insecticides for leafhopper (or broad-spectrum insecticide for GBM), it is very unlikely that it will be necessary to treat for grape leafhoppers in late August. If you do not observe much stippling it is not necessary to more carefully sample for leafhopper nymphs.

Figure 12. White stippling from feeding damage by eastern grape leafhopper on concord. Photo: T. Martinson.

Dr. Tim Martinson developed a modified approach to monitoring grape leafhopper based on the presence or absence of a certain amount of stippling of leaves (as depicted in a photograph on the scouting form) as the key to determining whether a leaf was “damaged” by leafhopper. His work showed that if you did the scouting in July while scouting for GBM you would head off any problems. At least in Concord, we have not seen where it has been a problem late in the season if it was not above threshold in July. The link to the scouting form is https://nysipm.cornell.edu/sites/nysipm.cornell.edu/files/shared/documents/GLH-scouting.pdf. This could be useful for those growers who do not want to count nymphs.

There are several choices of pesticides to use against leafhoppers. Sevin, or other carbaryl products, has been a standard for many years and is still effective except in isolated pockets of Concord and other native grapes around the Finger Lakes where we have observed control failures suggesting emergence of resistance. There are many effective alternatives to Sevin (see **New York and Pennsylvania Pest Management Guidelines for Grapes** for a full listing).

Potato Leafhopper

The potato leafhopper is quite distinct from grape leafhoppers discussed above. One big difference is that potato leafhopper originates each year from the southeastern US (it cannot successfully overwinter in upstate NY or PA) while grape leafhoppers are year round residents to our area. The overwintered, winged adults ride north on warm fronts and usually arrive in our area some time after bloom. When and where they arrive is not very predictable and some years are worse than others. Generally, though, we begin seeing signs of damage in early part of June. Potato leafhopper tends to arrive on Long Island before the Finger Lakes or Lake Erie regions. Vineyards adjacent to alfalfa sometimes get an infestation of potato leafhopper right after the alfalfa is mowed. The adult potato leafhopper is iridescent green and wedge-shaped while the nymph is usually green and moves sideway in a unique crab-like manner when disturbed. Instead of feeding on cell contents of leaves like grape leafhoppers, potato leafhopper adults and nymphs use their sucking mouthparts to tap into the phloem vessels (the tubes used by plants to transport products of photosynthesis) of a number of different species of plants including grapes. In the process of feeding, they introduce saliva into the plant that causes, to varying degrees, distorted leaf and shoot development (Fig. 13). Some cultivars of vinifera grapes seem particularly sensitive as does the French-American hybrid Cayuga White, but Labrusca cultivars also show symptoms. Feeding symptoms in grapes include leaves with yellow margins (more reddish for red Vinifera grapes) that cup downward. Often these symptoms are noticed before the leafhoppers themselves.

Figure 13. Distorted leaf and shoot development caused by Potato leafhopper feeding. Photo: D. Gadoury.

Potato leafhopper is a sporadic pest, although it can be serious in some places and some years. We currently do not have good estimates for an economic threshold. We do know that shoots will recover from feeding damage once the leafhoppers are removed. Several insecticides are registered for its control in grapes including Sevin, Danitol, Leverage, Assail, Admire Pro, Actara (not for use on Long Island), and Applaud (not for use on Long Island). *Note that products containing imidacloprid are considered restricted use pesticides in NY (not PA)*. Potato leafhopper is fairly mobile and it may require several treatments over the season as new infestations occur.

Grape Phylloxera

Grape phylloxera is an aphid-like insect with a complex life-cycle that causes galls on either leaves or roots (roots or leaves). There is a wide range in susceptibility of grape varieties to both gall types. **Leaf galls** are in the shape of pouches or invaginations and can contain several adults and hundreds of eggs or immature stages (Fig. 14). Leaf-galls first appear at low densities on the third or fourth leaf, probably originating from overwintered eggs on canes. The crawlers from these first generation galls disperse out to shoot tips and initiate more galls around the end of June or beginning of July. These second generation galls tend to be more noticeable. At high densities, leaf galls can cause reduced photosynthesis. Labrusca-type grapes and vinifera grapes tend to get few if any leaf galls. Some hybrid grapes, such as Baco Noir, Seyval, and Aurora, can become heavilyinfested with leaf galls.

Fig. 14. A single grape phylloxera leaf gall, with the side of the gall opened to show eggs and female. *Photo J. Ogrodnick.*

Root galls are swellings on the root, sometimes showing a hook shape where the phylloxera feed at the elbow of the hook. Root galls likely reduce root growth, the uptake of nutrients and water,and can create sites for invasion of pathogenic fungi. Labrusca grapes will get root galls but these tend to be on smaller diameter, non-woody roots that may reduce vine vigor in some cases, but are not lethal. The roots of vinifera grapes are very susceptible to the root-form of phylloxera, including galls on larger, woody roots that can cause significant injury and even vine death. Indeed, most vinifera grapes grown in the eastern US are grown on phylloxera-resistant rootstock and this is the primary method for managing the root-form of phylloxera.

Motivated by the difficulties associated with needing to hill up around grafted vines each winter to protect some buds of the scion in the case of a severe winter, we have conducted research to test whether we can manage root-form phylloxera well enough with insecticides to allow the use of own rooted vinifera vines in some circumstances. I won't go into details here, but we have shown, under on farm research conditions, that the insecticide Admire Pro, applied through a drip system, can greatly reduce phylloxera colonization of own-rooted vinifera over several years. I suspect that Movento, which is quite effective against grape phylloxera, could be used in a similar manner, though we have not explicitly tested it for this purpose. Overall, however, I generally would not recommend using own rooted vinifera in combination with insecticide for managing grape phylloxera. Using a good phylloxera resistant rootstock is a much safer way to go, although there might be very specific situations where own-rooted could make sense.

There are a couple of insecticides labeled for the control of leaf-form phylloxera, although we do not have a well-defined treatment threshold at this time. The neonicotinoid Assail (acetamiprid) and the pyrethroid Danitol (fenpropathrin) are labeled for the leaf-form of grape phylloxera as is the systemic insecticides Movento and Senstar. Soil applied Admire Pro is also systemic to the foliage and therefore will provide control of leaf-form phylloxera as well as some other sucking insects such as leafhoppers. Similarly, the neonicotinoid Platinum (cannot use on Long Island) is also labeled against grape phylloxera.

As noted above, imidacloprid applied through the soil (e.g. Admire Pro) is labeled for grape phylloxera as is Platinum and can provide some control of root phylloxera as well as leaf galls, especially when applied through a drip system. Movento, applied as a foliar spray, has also shown good efficacy on root- form phylloxera in our trials both with *V. vinifera* vines, but also with Concord. Recall that Concord and other native grapes are moderately susceptible to root galling phylloxera. Overall, our data indicate some benefit to using Movento on native grapes. There are a number of questions remaining, however, that warrant further study. How often does Movento need to be applied to maintain benefits? Can rates or number of applications be reduced while maintaining benefits? Will young vines benefit more or less from Movento compared to mature vines? What are the economics involved? To what extent will some of our hybrid grapes grown on their own roots benefit from Movento?

Grape Rootworm

Grape rootworm was a key pest of grapes in NY and surrounding areas in the early 1900s. Since the sixties, broad-spectrum insecticides targeting grape berry moth greatly reduced the impact of grape rootworm. However, with the use of more selective materials, and less use of insecticide overall in recent years, growers are observing more evidence of this pest, especially in the Lake Erie Region, but also in the Finger Lakes. Grape rootworm is a beetle in the Family Chrysomelidae (flea beetle family). You can find a fact sheet of grape rootworm at https://ecommons.cornell.edu/bitstream/handle/1813/43105/grape-rootworm-FS-NYSIPM.pdf. The adult (Fig 15) feeds on leaf material, creating characteristic chain like feeding damage (Fig 16). This damage is not economically significant but recognizing these symptoms can help in determining the start of adult emergence. The adults emerge over the middle part of the season, starting around bloom time. After an initial bout of leaf feeding, they mate and the females lay clusters of eggs on older canes, often under loose bark. The eggs hatch and the larvae drop to the ground where they work their way into the soil to find fine grape roots to feed on. Feeding damage by larger larvae cause reduced vine growth and vigor, increased vulnerability to stress, and reduced yields. Based on work by Tim Weigle, formerly with the NYS IPM Program, adults begin appearing in the Lake Erie region around or shortly after bloom (about 600 degree days, base 50 F) and peak around the third week of June (around 750 DD). Scouting for presence of adults is difficult as they are easily startled and will fall to the ground if

Fig. 15. Adult grape rootworm. Photo by J. Ogrodnick.

Fig. 16. Feeding injury by adult grape rootworm (chain like chewing). Photo: J. Ogrodnick.

disturbed. This behavior has been used to develop a scouting technique using a 2-foot square catching frame covered with a white cloth. To scout, place the catching frame under a vine and give the top wire a shake to dislodge adults. It is then easy to identify any grape rootworm that have fallen onto the catching frame. In terms of chemical control, it appears one well- timed insecticide is sufficient to greatly reduce adult populations. In the research trials, an insecticide applied as soon as scouting indicated the presence of adults provided season long control. In general, we recommend scouting for adult feeding damage around bloom for evidence of adult activity. Also, continue to follow email alerts from the regional grape programs. There are five different insecticides labeled to control grape rootworm: Sevin, Sniper (2ee), Danitol 2.4 EC (2ee), Leverage 360 (2ee), and Admire Pro (2ee). Keep in mind your grape berry moth management strategy when choosing a material for grape rootworm. Seasonal limits should be taken into consideration so you do not find yourself without good options later in the season. Even though the adult stage does not cause significant damage to vines, it is the target of the insecticides to prevent egg laying and larval infestation. Adult female grape rootworm require a week or two of leaf feeding (pre-oviposition period) before they start to lay eggs. Hence, knowing when adults have emerged from the ground is critical to successful chemical control.

Spider Mites

There are two species of spider mites that attack grapes in the Eastern US; two-spotted spider mite (TSSM) and European red mite (ERM), but ERM typically is the more common. It is important to know the difference between the two species since some miticides are more effective against one than the other. Problems with spider mites tend to be more serious in hot and dry years and later in the season. An important difference between the two spider mite species is that ERM overwinters on grapes as eggs in bark crevices of older wood while TSSM overwinters as adult females, probably in ground cover. As the name indicates, ERM is reddish in color and lays red eggs (Fig. 17). Adult female TSSM tend to have large black spots on the top of the abdomen but this is pretty variable. TSSM eggs are clear to opaque. TSSM tends to stay on the bottom side of leaves and produces obvious webbing while ERM can be found on either side of the leaf and does not produce much webbing. Both species have the capacity to go through a number of generations during the season. However, we typically do not see significant populations and damage until mid to late summer. This is especially true of TSSM since they do not start off on the vine.

Fig. 17. Adult European red mite. Photo by J. Ogrodnick.

Because of their small size, it is often difficult to know if you have mites. Foliar symptoms (bronzing of leaves, see Fig 18) are one clue, although if you have wide spread, obvious symptoms then economic damage may already be occurring. The working threshold for spider mites (TSSM and ERM combined) in our area is 7 to 10 mites per leaf, although this will vary depending on health of the vineyard, crop load, value of the grape, etc. In summer, I suggest sampling at least 50 mid-shoot leaves from both the edge and the interior (25 leaves each) of a vineyard block, examining both sides of the leaf. A hand lens will be necessary to see the mites for most people. Even with a hand lens, it is challenging to count the mites. Thus, we recommend estimating the proportion of leaves infested with mites and use something like 50% infested as a treatment threshold. A leaf is considered infested if it has one or more spider mites. Remember to keep rough track of which species is most common.

Fig. 18. Leaf bronzing on Riesling. Photo by S. Hesler.

There are several chemical options available for mite control in New York and Pennsylvania: Vendex [fenbutatin-oxide], Agri-Mek plus several generics [abamectin], Nexter [pyridaben] (not on Long Island), Acramite [bifenazate], JMS Stylet Oil [aliphatic petroleum distillate], Zeal Miticide1 [etoxazole], Onager or Savey [hexythiazox], Danitol [fenpropathrin], Portal [fenpyroximate] and Nealta [cyfmetofen]. There is also a new miticide recently labeled for use on grapes, Magister SC [fenazaquin], in the same class of acaricides as Nexter, although it is allowed for use on grapes on Long Island. Read labels carefully. JMS Stylet Oil is not compatible with a number of other products including Captan, Vendex, and sulfur. Also, although Stylet Oil can help with mite problems, it is not likely to provide complete control in problem vineyards. Nexter is very effective against ERM but higher rates should be used for TSSM. It also provides some partial control of leafhoppers. Agri-Mek currently has TSSM on the label but not ERM, although in apples both species are on the label. Acramite includes both TSSM and ERM, although it calls for higher rates for ERM. Zeal miticide 1 includes both ERM and TSSM the label. Since Zeal miticide 1 affects eggs and immatures, it is advised to apply before populations reach damaging levels to give the material time to work. Similar advice can be applied to Onager, Savey and Portal. Danitol and Brigade and Hero (two-spotted only) are broad-spectrum pyrethroid insecticides that also have fairly good miticidal activity. Pyrethroids are hard on beneficial mites, however.

Spider mites are often thought of as a secondary pest. In other words, typically something must happen in the vineyard that disrupts their natural control by predators, particularly predatory mites, before their populations increase to damaging levels. Several broad-spectrum insecticides used in grapes, including Danitol, Brigade, Brigadier, Leverage, Baythroid and possibly Sevin can suppress predatory mites. Since Danitol and Brigade have miticidal activity they would not be expected to flare spider mites in the short term. However, in the past, spider mites have been quick to develop resistance to frequent use of pyrethoids. The other miticides (Vendex, Onager, Savey, Zeal, Acramite, Nealta, and Nexter) are generally pretty easy on natural enemies, although at high rates Nexter can negatively affect predatory mites. Overall, paying attention to conserving predatory mites can pay economic dividends since miticides are, in general, expensive.

Japanese Beetle

The adults (1/2 inch body, metallic green in color, Fig 19) seem to have a fondness for grape foliage, but also feed on a number of other plant species. Although the adults have broad diets, the larvae (Fig 20) feed principally on the roots of grasses. Hence, we often find the most significant problems with adult Japanese beetles in areas surrounded by an abundance of turf. The fact that most vineyards have sod row middles may exacerbate problems with adults. The adults emerge from the soil in mid-summer and begin feeding and then mating and egg-laying. The feeding damage caused by adults can be quite extensive, perhaps exceeding 10 or 20% of the foliage. Fortunately, mature grapes are fairly tolerant of this type of feeding at this time of the season. The exact amount is hard to nail down but it seems that up to 15 or 20% leaf damage has little impact on yield parameters. Note, though, that the actual impact of leaf feeding will depend on a number of factors including health and size of the vine and the cultivar. Moreover, if it is a high value cultivar then the economic injury level will be lower compared to a lower value cultivar. Young vines may be particularly vulnerable in that they have fewer reserves to draw upon to recover from damage. You should make a special effort to regularly monitor vines inside growth tubes for Japanese beetles and apply insecticides directly into the tubes if treatment iswarranted. Grape cultivars do seem to vary in resistance to foliar feeding by Japanese beetle adults. Thick leaved native cultivars are the most resistant followed by hybrids and then *V. vinifera*.

Fig. 19. Adult Japanese beetle on grape leaf. Photo: S. Hesler

Fig. 20. Later instar immature Japanese beetle grub. Photo: S. Hesler

There are several insecticides labeled for use against Japanese beetles on grapevines. These all are roughly similar in efficacy but they do vary in impact of beneficial arthropods like predatory mites. Also keep in mind that the adults are very mobile and can re-colonize a vineyard block after being treated with an insecticide. Regular monitoring of the situation is recommended.

Drosophila Fruit flies

Fig. 21. Vignole cluster with sour rotted berries. Photo: R. Bhandari.

Drosophila fruit flies (or vinegar flies) have generally been thought of more as a pest or nuisance in wine cellars but not so much as pests in vineyards. However, we now know that several species of vinegar flies can contribute to sour rot in wine grapes (see Fig. 21) for susceptible cultivars, especially when favorable environmental conditions exist. Favorable weather conditions include above average temperatures and precipitation after veraison. As you know, 2021 was a bad sour rot year in the eastern US. Not coincidently, 2021 had above average precipitation in August and September. In Geneva, we had over 3 inches of rain in mid-August along with above average temperatures (see Fig 22). We observed sour rot symptoms in our research planting of Vignoles at AgriTech Immediately after this 3-inch rain event.

Drosophila fruit flies contribute to sour rot in two ways: by spreading microorganisms that help cause sour rot (acetic acid bacteria and yeast) and the activity of the larval stage exacerbates symptoms. The most common species of vinegar fly found associated with sour rot is *Drosophila melanogaster* but the relatively new invasive vinegar fly Spotted Wing Drosophila (SWD) (also known as *Drosophila suzukii*) also directly contributes but also may facilitate activity of *D. melanogaster*. Both species can become very abundant in the environment close to harvest. For more information on sour rot and the role of vinegar flies see cornell.edu/sites/grapesandwine.cals.cornell.edu/files/shared/Research%20Focus%202017-3.pdf).

For managing sour rot in a year that has weather conditions conducive to high sour rot risk like occurred in 2021, we are currently recommending weekly insecticide control of vinegar flies, plus pesticides targeting the causal microbes (e.g. Oxidate), starting at about 12-15 Brix for susceptible wine cultivars. However, we have field data over two field seasons (2020, a low sour rot season, and 2021, a high sour rot season) suggesting that applying insecticide at around 12-15 Brix and one other time closer to harvest was as effective as weekly applications, so it's possible that weekly applications are not necessary. However, our research trials used relatively small plot sizes, so we want to test this idea on a larger, more realistic scale using commercial vineyard trials.

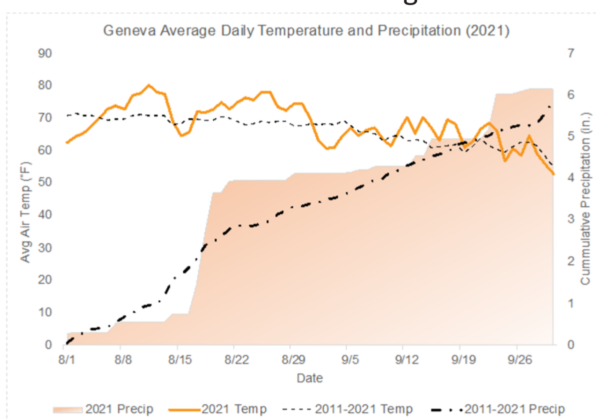

Fig. 22. Average temperatures and precipitation in 2021 at Geneva AgriTech along with 10 year averages (2011-2021).

In addition to costs of materials and labor associated with insecticide applications for sour rot, there is also concern about insecticide resistance. We now have good evidence that NY populations of *D. melanogaster* (and probably populations in other eastern US grape growing areas) show some level of resistance to three out of the four insecticide classes labeled for use on grapes for Drosophila fruit flies (a pyrethroid – Mustang Maxx, an organophosphate – Malathion, and a neonicotinoid - Assail) with only the spinosyn (Delegate) not showing clear evidence of resistance, although we have found a few populations that are showing worrying signs. This is based on testing field collected *D. melanogaster* in the lab against different concentrations of insecticide compared to a known susceptible *D. melanogaster* population. Although our laboratory evidence suggests significant levels of resistance to three insecticides, it's important to note that this does not directly translate into field failure. Nevertheless, there is clearly a risk of resistance developing leading to control failures and therefore, it behooves the industry to manage the situation. This means applying insecticides for managing sour rot only when required by reducing risk factors including minimizing fruit injury from birds or insects such as yellow jackets, in order to reduce fly access to fruit, and rotating materials among different modes of action.

Fig. 23. Adult Multicolored Asian Ladybeetle. Photo from USDA. The M or W markings on pronotum (shield behind head) is diagnostic for MALB. The over all color or spots is less helpful for identification.

There are several different insecticides labeled for use on grapes for vinegar flies. Some of these specifically list spotted wing drosophila while others list vinegar flies more generally. A full list is included in the NY and PA Pest Management Guidelines for Grapes. Be cognizant of days to harvest restrictions (e.g Danitol, has a 21 d DTH while Mustang Maxx has a 1 d DTH), target species and whether a 2ee is required (in NY).

Multicolored Asian Lady Beetle (MALB)

MALB (Fig. 23) was introduced into the US from Asia to help control aphid pests. It has spread to many areas in the southern and eastern US and into Ontario Canada and has generally been an effective biological control agent. However, it has the habit of moving into vineyards in the fall near harvest time (Fig. 24). When disturbed, the adult MALB releases a defensive chemical out of its joints (methoxypyrazines) that helps it ward off enemies. Unfortunately, the defensive chemical has a nasty taste and offensive odor at very low detection levels that gets carried into the juice and wine. Relatively low densities of MALB (10 per grape lug) can cause off-flavors in juice and wine.

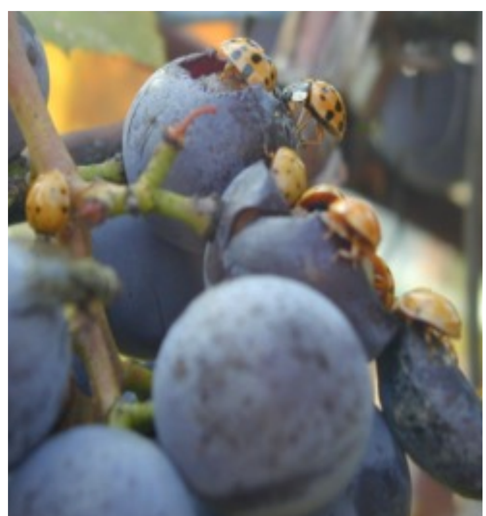

Fig. 24. Adult Multicolored Asian Ladybeetles in a concord grape cluster in the fall. Photo: J. Kovach, OSU.

MALB is sporadic both in where it shows up during a given year and from year to year. Vineyards adjacent to soybeans in a year when soybean aphid is abundant may be more vulnerable. **Pay attention to**

the crop updates of the regional grape extension programs as we get into harvest to see if and when MALB is turning up in vineyards. Then scout your vineyards before harvest. Late harvested varieties are usually the most vulnerable. The economic injury level for Concord grapes has been established at about 6 beetles per 10 pounds of fruit by National Grape Cooperative. For wine grapes, something in the range of 5 beetles per 25 clusters could result in off-flavors. There could be several different species of ladybugs in your vineyard but probably only MALB would be at high densities on the clusters. You can recognize MALB by the black markings directly behind the head that look like an M or W depending on which direction you look from. The color or number of spots is variable. The abundance of MALB appears to be closely tied to the abundance of soybean aphid.

There are a few chemical approaches to managing MALB in New York: Mustang Maxx, Aza-Direct and Evergreen [natural pyrethrins]. Mustang Maxx has a 1 DTH restriction. Aza-Direct, which is based on the active ingredient azadirachtin from the neem tree, appears to have a repellent effect on MALB, based on trials by Roger Williams at Ohio State. Based on a trial a few years ago by Tim Weigle, Evergreen appears to have both toxic and repellent effects on MALB. Aza-Direct and Evergreen have no days to harvest restrictions. For Aza-Direct, pH in spray water should be 7 or less (optimum is 5.5 to 6.5). The neonicotinoid insecticide Venom [dinotefuran] has shown good efficacy against MALB (both toxic and repellent) in trials conducted by Rufus Isaacs at Michigan State University. It only has a 1 day to harvest restriction. Venom is labeled for use in PA but not NY. A 2(ee) label expansion for Admire Pro [imidacloprid] has also been approved for use in NY. Admire Pro has a zero day to harvest interval when applied to foliage. Imidacloprid has both toxic and repellent effects on MALB similar to Venom.

Bottom line comments

The bottom-line message for insect and mite pests is to regularly monitor your grapes. There is no guarantee that a particular pest will show up in a particular year or at a particular site. Moreover, you typically have time to react using an eradicant if a pest does reach sufficient densities to cause economic damage. Knowledge of what is present will lead to better management decisions.

During the period after budbreak to bloom **plant bugs (banded grape bug and *Lygocoris inconspicuous*)** represent the greatest insect risk for yield loss. Most vineyard blocks escape serious damage from plant bugs most years but every year I find sites with significant numbers that managers don't know about. Monitor for the nymphs at about 7-10-inch stage, keying in on the flower buds. If you find more than one nymph per 10 clusters, consider an insecticide treatment such as Sevin or Danitol or Assail. Remember that only the nymphs cause significant damage. Treatments close to bloom are probably too late to do much good since most nymphs have completed development and become adults. Other than plant bugs, there are relatively few insect pests between budbreak to bloom period that can cause significant harm. For those sites where **grape cane gallmaker** has become problematic, this is the time period where control should be applied. Also, sites with sandy soils may experience damaging populations of **rose chafer** at around bloom time. The light-brown adult beetles feed on flowers and young clusters and can reduce yields. **Grape rootworm** also comes out around bloom or a little after. Adult beetles cause characteristic chain like feeding damage on lower leaves. It's the larval stage that causes the significant injury, feeding on roots. Chemical control targets the adult stage.

Mid-summer to harvest is the time where insects and mites often create the most concern. On the top of the list is **grape berry moth**. Traditionally for high-risk sites we have recommended an insecticide during the postbloom period to kill first generation larvae. But except for super high-risk sites or high value varieties, our research indicates this postbloom spray is not useful. Focus should be on the second-generation and third-generation larvae in mid-summer and late summer and in warm years, late summer/early fall damage from a combination of third and fourth generation larvae. Timing of insecticides is important. Insecticides mostly target the egg and young larva before it penetrates the berry. **Check out the temperature-based phenology forecast model available online at http://newa.cornell.edu/ (look under pest forecast models for grape berry moth).** This model can help you better time the occurrence of grape berry moth flight activity for the second and third flights. It has not been as useful for timing late season GBM. **In warm years and in high-risk sites, growers need to continue chemical control on a 10 to 14 day interval from mid-August to mid-September. Good coverage of the fruiting zone is essential.**

Two other pests are worth mentioning for the mid-summer period. One is conspicuous and you probably will be tempted to spray for it even if it does not make economic sense to do so because the damage looks bad. I am speaking of **Japanese beetle**. Granted, these guys can do alot of feeding during July. But remember that for a healthy vineyard, especially a vigorous one, the vines can probably handle conservatively 15% foliar damage. If you do need to treat, be aware of the potential for some insecticides to flare spider mites. **Spider mite** is the second pest I wanted to mention. They are actually not very conspicuous and, as a consequence, growers may miss them. Be on the lookout for yellowing or bronzing leaves and generally low thrift during the hot days of late July and August.

Toward harvest keep an eye out for **multicolored asian lady beetle (MALB)**. This normally beneficial insect can become a pest at this time of year by congregating in the clusters at harvest. It has primarily been an issue for late harvested varieties. The adult beetle releases a noxious chemical when disturbed (such as by harvesting the fruit) and this can taint wine and juice. Their populations have been fairly low in recent years although we have seen exceptions, especially in areas where soybeans are also being grown. **For late maturing cultivars it is essential that you monitor clusters for MALB close to harvest and take appropriate action if they are present.** Keep an eye out for email alerts from your regional grape extension programs.

The other late-season insect pests we have concerns about are **fruit flies**, both the regular vinegar flies and the new invasive spotted wing drosophila. Our concern centers on their role in promoting sour rot. Because sour rot can be devastating in a bad year, the temptation is to apply insecticides to control vinegar flies after about 12 or 13 Brix for susceptible cultivars. However, the development of insecticide resistance in *D. melanogaster* has changed the cost-benefit analysis and more than ever, it’s important to be judicious in their use as well as rotating among different insecticide classes. Be aware of risk factors such as above average rainfall in August coupled with warm temperatures and berry injury. Try to minimize berry injury as much as feasible.

Finally, for NY vineyards and for vineyards in the Lake Erie Grape Belt be on the alert for spotted lanternfly. Nymphs start appearing in later May but may be hard to spot. Adults appear in August, generally on trees in the landscape, especially tree of heaven, but also start flying into vineyards. Report new sightings in NY to NYS Ag & Markets and also to your local extension person.

In summary, there is a seasonality to pests and checking the electronic updates from your regional grape extension programs is an excellent way to stay on top of what you should be on the look out for during the season. Generally speaking we have good chemical control options available for most arthropod pests if necessary. But be smart about using them. Pay attention to label restrictions and review recommendations in the pest management guidelines. Rotate among materials with different modes of action (see IRAC codes on labels) to reduce development of resistance. Be aware of consequences of your choice of pesticides on natural enemies and other beneficial arthropods. Most important, only use pesticides or other control options when it makes economic sense to do so (monitor and apply economic thresholds where available). If you have questions, contact your regional extension office or you can also contact me at my office (315-787-2345) in Geneva or through email at gme1@cornell.edu. I am looking forward to seeing you out in the vineyards this field season.